799 Coronary Angiography by DSA, Electron Beam Computed Tomography, and Magnetic Resonance Imaging

Wednesday, March 27, 1996, 2:00 p.m.–3:30 p.m.
Orange County Convention Center, Room 224B

2:00

799-1 Intravenous Coronary Angiography by Use of Dichromography With Synchrotron Radiation

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Dichromography represents a digital subtraction angiography mode based on energy substraction which allows imaging of fast moving subjects like the heart. Energy of sufficient intensity to visualize coronary arteries of 1 mm diameter with extremely low iodine concentrations (1 mg/cm^2) is provided by synchrotron radiation (3×10^{11} photons/mm^2/s). For substraction two images just below and above the iodine K-edge (33.17 KeV) were simultaneously obtained in a line scan mode. We describe the first clinical experience in 60 patients (60 ± 12 years) undergoing synchrotron coronary angiography for follow-up of PTCA (n = 46) or CABG (n = 14). For 120 images 20 to 30 ml contrast (370 mg/ml iodine) was injected in the v. cava superior (n = 84), v. subclavia (n = 4) or v. cubitalis (n = 32). Images to allow therapeutic decision making were obtained in 44/49 (90%) right coronary arteries, 38/46 (83%) LAD and 26/26 (100%) vein grafts. Loss of quality was most pronounced in the A. circumflex (n = 35) due to the superimposed left ventricle and pulmonary vessels. In 8/60 pts the synchrotron images resulted in hospital admission. *Conclusions:* This new, minimal invasive imaging modality is feasable and appears promissing for large scale use. Further investigations and technical developments are warranted.

2:15

799-2 A Comparison of Electron Beam Tomography and Quantitative Coronary Angiography

Stephan Achenbach, Werner E. L. Moshage, Kurt Bachmann. *University of Erlangen-Nürnberg, Germany*

Electron Beam Tomography (EBT) is a non-invasive imaging method with high spatial and temporal resolution. It permits the 3-dimensional reconstruction of the coronary arteries after intravenous injection of contrast agent. We compared this new method to quantitative coronary angiography (QCA).

8 patients (6 male, 2 female, mean age 57 years) were investigated by EBT and QCA. After intravenous injection of contrast agent (120 to 160 ml), 40 axial cross-sections of the heart were acquired triggered to the ECG (2 mm slice thickness, 100 ms acquisition time per image). The contrast-enhanced inner vessel lumen was reconstructed 3-dimensionally. The patients were investigated by conventional coronary angiography on the following day. In corresponding sites, the coronary artery diameters were measured in the reconstructed EBT images and in the coronary angiograms using off-line QCA.

Vessel diameters were compared at 53 corresponding sites (3 LM, 26 LAD, 2 diagonal branch, 5 LCX, 13 RCA, 4 CABG). The mean diameter in EBT was 3.12 ± 0.86 mm (0.0–4.9 mm) and in QCA 3.05 ± 0.93 mm (0.4–4.8 mm). The correlation coefficient was 0.81. If only corresponding sites of the left main, LAD and diagonal branch were compared (n = 31), the correlation coefficient was 0.87.

3-d reconstructed contrast-enhanced EBT permits reliable imaging of the coronary arteries. Probably due to faster vessel movements, the measurements of the LCX and RCA are less exact than of the left main and LAD.

2:30

799-3 Non-Invasive Detection of Restenosis After PTCA by Contrast-Enhanced Electron Beam Tomography

Werner E.L. Moshage, Stephan Achenbach, Bernd Seese, Kurt Bachmann. *University of Erlangen-Nürnberg, Germany*

Contrast-enhanced electron beam tomography (EBT, ultrafast CT) permits the non-invasive visualization of the coronary arteries. We investigated the method's potential to detect restenosis in the follow-up of coronary angioplasty (PTCA)

20 patients (17 ♂, 3 ♀, mean age 57 years) were investigated by EBT one day before scheduled routine follow-up coronary angiography 3 months after PTCA (8 LAD, 6 LCX, 6 RCA). 3 patients carried intracoronary STENTs after PTCA of the RCA. EBT was performed after injection of 120–160 ml of contrast agent in a peripheral vein. Triggered to the ECG, 40 axial cross-sections of the heart were obtained (slice thickness 2 mm, acquisition time 100 ms, spatial resolution 0.08 mm^2). 3-D reconstruction was performed with a lower threshold of 80 HU to selectively visualize the contrast-enhanced inner coronary artery lumen. Evaluation was performed by 2 independent investigators blinded to the angiograms.

2 patients were excluded from evaluation due to extensive respiration artifacts. In the remaining 15 patients without STENT, all 5 recurrent stenoses (3 LAD, 2 RCX) were clearly identified in the EBT images by both investigators. In 9/10 patients, EBT correctly predicted absence of recurrent stenosis; in 1 patient, LCX restenosis was incorrectly diagnosed by one EBT investigator. Overall interobserver agreement was 95%. No statement concerning STENT restenosis could be made due to metallic artifacts.

Contrast-enhanced EBT, a minimally invasive method for the visualization of the coronary arteries, permits the detection of restenosis in the follow-up after PTCA with high sensitivity and specificity.

2:45

799-4 Three-Dimensional Respiratory-Gated Magnetic Resonance Angiography of Coronary Arteries Compared With Conventional X-Ray Contrast Angiography

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Background: Magnetic resonance coronary angiography (MRCA) is currently performed using two-dimensional techniques. Three-dimensional (3D) acquisitions have several advantages but take too long to run within a breath-hold, thus being susceptible to respiratory motion artefacts. *Purpose:* To investigate the clinical value of coronary imaging using a novel respiratory-gated 3D MRA technique. *Methods:* In a prospective blinded study we investigated 20 pts referred for conventional coronary angiography (CAG). A cardiac-gated fast 3D gradient-echo technique with fat-suppression was used to image a transverse volume encompassing the proximal coronary arteries (CAs). Voxel size was 1.2 × 2.3 × 2.1 mm^3. Retrospective respiratory-gating was performed using simultaneously acquired navigator echoes of the diaphragm position. Multiplanar reformatting of transverse and oblique images was used to visualize the coronary arteries. Blinded analysis of the images was performed by 2 independent observers for: *(1)* visualization of major coronary arteries; *(2)* lengths of imaged segments; *(3)* detection of significant stenoses (> 50% luminal diameter by CAG). *Results: (1)* 77 out of 80 major epicardial CAs (96%) could be positively identified. In one of the pts an anomalous CA anatomy was readily identified and confirmed by CAG. *(2)* Mean lengths of the imaged segments for the RCA, LMCA, LAD and LCx were 58 ± 13 mm, 9 ± 5 mm, 59 ± 16 mm and 24 ± 10 mm, respectively. *(3)* Overall sensitivity for the detection of hemodynamically significant stenoses was 0.38 with a specificity of 0.95. Inter-observer agreement was 0.92 with good kappa value (0.65).

Conclusion: Respiratory-gated 3D MRA allows accurate identification of 96% of proximal major CAs and may be valuable for 3D imaging of CA anomalies. Further technical improvements are required to make the technique valuable for the detection of stenoses.

3:00

799-5 Three Dimensional Cine of Human Coronary Vessels Using Echoplanar MRI

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We have used echoplanar magnetic resonance imaging (MRI) to create three dimensional, moving images of the coronary vessels of the beating human heart in a single breathhold, in less than one minute. Existing MRI techniques provide a static image, require careful plane selection and/or suffer from motion artifact, and take 30 to 60 minutes.

All 28 normal volunteers successfully held their breath for 55 seconds after brief hyperventilation. Parameters for the echoplanar gradient echo pulse sequence were TR = 118 ms, TE = 37 ms, flip angle 90°, thickness 5 mm, FOV 40 × 20 cm, 256 × 128 pixels, table sweep speed 3 mm/sec, and 5 inch surface coil. The resulting two dimensional axial images were postprocessed using a novel wavelet packet "denoising" algorithm, sorted into 10 cardiac phases and each phase processed into a 3D image; the 10 phases are then displayed as a cine.

The coronary vessels can be seen as branching tubular structures on the surface of the beating heart (a video will be presented). The left main and proximal two thirds of the RCA can be seen in all volunteers, as can the proximal two thirds of the LAD.